

1 description. All changes which come within the meaning and range of equivalency of the
2 claims are to be embraced within their scope.

3 What is claimed and desired to be secured by United States Letters Patent is:
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- 1 1. A device for separating and detecting particles comprising:
2 a capillary having a first end and a second end, the capillary filled with a buffer
3 solution;
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5 an electrical source for applying a voltage across the capillary, the voltage
6 causing the particles to travel from a first location within the capillary to a second
7 location within the capillary; and
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9 a detector for determining the location of particles within the capillary, the
10 detector capable of determining the location of particles at more than one position along
11 the length of the capillary.
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14 2. The device of claim 1, further comprising a first reservoir in fluid
15 communication with the first end of the capillary, the first reservoir configured to contain
16 buffer solution and a second reservoir in fluid communication with the second end of the
17 capillary, the second reservoir configured to contain buffer solution.
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20 3. The device of claim 1, further comprising a fluorescent label attached to
21 the particles.
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24 4. The device of claim 3, wherein the detector further comprises an excitation
25 source for directing an excitation beam onto the fluorescently labeled particles within the
26 capillary, the fluorescently labeled particles emitting light after excitation with the
27 excitation beam.
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- 1 5. The device of claim 4, wherein the detector further comprises a light
2 detector positioned to collect fluorescent light emitted from the excited fluorescently
3 labeled particles.
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- 6 6. The device of claim 5, wherein the light detector comprises low-level light
7 detection electronics.
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- 10 7. The device of claim 5, further comprising a coating on the capillary which
11 transforms the capillary into a light wave guide directing the fluorescent light toward the
12 light detector.
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- 15 8. The device of claim 7, wherein the coating has a refractive index number
16 in the range from about 1.1 to about 1.4.
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- 18 9. The device of claim 7, wherein the coating has a refractive index number
19 of about 1.3.
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- 22 10. The device of claim 8, wherein, the coating is polytetrafluoroethylene.
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- 25 11. The device of claim 4, wherein the excitation beam has a power in the
26 range from about 1 mW to about 1000 mW.
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- 1 12. The device of claim 4, wherein the excitation beam has a width in the
2 range from about 5 μm to about 1000 μm .
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- 5 13. The device of claim 4, wherein the light detector can distinguish between
6 more than one color of fluorescent light.
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- 9 14. The device of claim 4, wherein the light detector may be placed at either
10 end or both ends of the separation capillary.
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- 13 15. The device of claim 1, further comprising a plurality capillaries.
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- 16 16. The device of claim 1, wherein the electrolyte buffer comprises tris-boric
17 acid EDTA, potassium tartrate, tris-acetate EDTA, a gel sieving material, and a surface
18 deactivating agent.
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- 21 17. The device of claim 16, wherein the gel sieving material is selected from
22 the group consisting of poly(ethylene glycol), poly(vinyl alcohol), hydroxy propyl
23 methyl cellulose, hydroxyethylcellulose, and linear polyacrylamide.
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- 26 18. The device of claim 16, wherein the surface deactivating agent is
27 poly(vinylpyrrolidone).
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- 1 19. A device for separating and detecting particles comprising:
2 a capillary having a first end and a second end the capillary filled with a buffer
3 solution;
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5 a first reservoir in fluid communication with the first end of the capillary, the
6 first reservoir configured to contain buffer solution;
7
8 a second reservoir in fluid communication with the second end of the capillary,
9 the second reservoir configured to contain buffer solution;
10 an electrical source for applying a voltage across the capillary, the voltage
11 causing a fluorescently labeled particle positioned within the capillary to travel from a
12 first location within the capillary to a second location within the capillary;
13
14 an excitation source for directing an excitation beam onto the capillary, such that
15 when a fluorescently labeled particle is positioned within the capillary, the fluorescently
16 labeled particle emits light after excitation with the excitation beam;
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18 the excitation source capable of exciting fluorescently labeled particles at more
19 than one position along the capillary; and
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21 a light detector positioned to collect fluorescent light emitted from excited
22 fluorescently labeled particle located within the capillary.

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25 20. The device of claim 19, further comprising a coating on the capillary
26 which transforms the capillary into a light wave guide capable of directing the fluorescent
27 light toward the light detector.
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- 1 21. The device of claim 19, wherein the coating has a refractive index of about
2 1.3.
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5 22. The device of claim 19, wherein, the coating is polytetrafluoroethylene.
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8 23. The device of claim 19, wherein the light detector comprises a fiber optic
9 coupled end-on to the capillary.
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12 24. The device of claim 19, wherein the light detector comprises low-level
13 light detection electronics.
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16 25. The device of claim 24, wherein the low-level light detection electronics
17 are selected from the group consisting of photomultipliers, photodiodes, and CCD
18 cameras.
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21 26. The device of claim 24, wherein the light detector further comprises an
22 optical filter, prism, grating, or light spectrometer positioned between the light detection
23 electronics and the capillary for filtering incident light, and the resulting fluorescence.
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26 27. The device of claim 26, wherein the optical filter comprises a high band
27 pass filter for filtering light with a wavelength greater than about 500 nm and a notch
28 filter.
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1 28. The device of claim 26, wherein the optical filter comprises a narrow band
2 pass filter which filters light other than light with a wavelength corresponding to the
3 wavelength of the light emitted from the fluorescent label, ± 10 nm.
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6 29. The device of claim 19, wherein the excitation beam is rastered along part
7 or all of the length of the capillary.
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10 30. The device of claim 19, wherein the excitation beam has a power in the
11 range from about 1 mW to about 1000 mW.
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14 31. The device of claim 19, wherein the excitation beam has a width in the
15 range from about 5 μm to about 1000 μm .
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18 32. The device of claim 19, wherein the light detector can distinguish between
19 more than one color of fluorescent light.
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22 33. The device of claim 19, further comprising a plurality capillaries.
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25 34. The device of claim 19, wherein the electrolyte buffer comprises tris-boric
26 acid EDTA (TBE), potassium tartrate, tris-acetate EDTA (TAE), a gel sieving material,
27 and a surface deactivating agent.
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1 35. The device of claim 34, wherein the gel sieving material is selected from
2 the group consisting of poly(ethylene glycol), poly(vinyl alcohol), hydroxy propyl
3 methyl cellulose, hydroxyethylcellulose, or linear polyacrylamide.
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6 36. The device of claim 16, wherein the surface deactivating agent is
7 poly(vinylpyrrolidone).
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10 37. The device of claim 34, wherein the gel sieving material is at a
11 concentration in the range from about 0.1% to about 5% and has a viscosity in the range
12 from about 0.5 cp to about 50 cp at room temperature.
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15 38. The device of claim 19, wherein the capillary has a length in the range
16 from about 5 cm to about 100 cm.
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19 39. The device of claim 19, wherein the capillary has a length of about 20 cm.
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22 40. A method for separation and sizing of particles in short channels by
23 capillary electrophoresis comprising:
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25 obtaining a sample of particles;
26 fluorescently labeling the particles;
27 loading the sample into a device for separating and sizing particles, the device
28 comprising a capillary having a first end and a second end filled with a buffer solution, a
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1 first reservoir in fluid communication with the first end of the capillary, the first reservoir
2 configured to contain the buffer solution, a second reservoir in fluid communication with
3 the second end of the capillary, the second reservoir configured to contain the buffer
4 solution, an electrical source for applying a voltage across the capillary, the voltage
5 causing the fluorescently labeled particles to travel from a first location within the
6 capillary to a second location within the capillary, an excitation source for directing an
7 excitation beam onto fluorescently labeled particles within the capillary, the fluorescently
8 labeled particles emitting fluorescent light after excitation with the excitation beam, the
9 excitation source capable of exciting the fluorescently labeled DNA particles at more than
10 one position along length of the capillary, and a light detector positioned to collect the
11 fluorescent light emitted by the excited fluorescently labeled particle;

12 applying the voltage across the capillary;
13 rastering the excitation beam on the capillary;
14 monitoring fluorescent light in the light detector; and
15 comparing the position of the excitation beam on the capillary when light is
16 collected by the light detector to determine the position of the particles in the capillary;
17 and
18 determining the relative size of the particles from the determined position.

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26 41. The method of claim 40, wherein the device further comprises at least one
27 additional capillary having a first end and a second end, the at least one additional
28 capillary filled with buffer solution and in fluid communication with the first and second
29 capillary filled with buffer solution and in fluid communication with the first and second
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1 reservoirs, the method further comprising obtaining a second sample of particles of a
2 known size, fluorescently labeling the particles of the second sample, applying the
3 voltage across the at least one additional capillary, rastering the excitation beam on the at
4 least one additional capillary, monitoring the collection of fluorescent light in the light
5 detector; and comparing the position of the excitation beam on the capillary when light is
6 collected by the light detector to determine the position of the particles of known size,
7 comparing the position of the particles of known size to the position of the sample
8 particles to determine the size of the sample particles.
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13 42. The method of claim 41, wherein the voltage is in the range of about 4,000
14 V to about 20,000 V dc.
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17 43. The method of claim 41, wherein the capillary has a length in the range of
18 about 5 cm to about 100 cm.
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21 44. The method of claim 43, wherein the length is in the range of about 10 cm
22 to about 25 cm.
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25 45. The method of claim 43, wherein the length is in the range of about 20 cm.
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1 46. The method of claim 41, wherein the particle is selected from the group
2 consisting of a nucleic acid, a protein, inorganic ions, and organic ions, and neutral
3 species.
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6 47. The method of claim 41, wherein the device further comprises a coating
7 on each of the capillaries which transforms the capillary into a light waveguide directing
8 the fluorescent light toward the light detector.
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11 48. The method of claim 47, wherein the coating has a refractive index of
12 about 1.3.
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15 49. The method of claim 47, wherein the coating is Teflon® AF.
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18 50. A method for sequencing DNA comprising:
19 obtaining a sample of DNA to be sequenced;
20 running a dideoxy sequencing reaction on the DNA sample, the sequencing
21 reaction comprising a separate reaction mixture for each nucleotide type, each reaction
22 mixture comprising a different fluorescent label, each reaction mixture run to form a
23 separate reaction product;
24 pooling the reaction products of the reaction mixtures;
25 loading the pooled reaction products into a device for separating and detecting
26 particles, the device comprising a capillary having a first end and a second end filled with
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1 a buffer solution, a first reservoir in fluid communication with the first end of the
2 capillary, the first reservoir configured to contain the buffer solution, a second reservoir
3 in fluid communication with the second end of the capillary, the second reservoir
4 configured to contain the buffer solution, an electrical source for applying a voltage
5 across the capillary, the voltage causing the fluorescently labeled reaction products to
6 travel from a first location within the capillary to a second location within the capillary,
7 an excitation source for directing an excitation beam onto the fluorescently labeled
8 reaction products within the capillary, the fluorescently labeled reaction products emitting
9 fluorescent light after excitation with the excitation beam, the excitation source capable
10 of exciting the fluorescently reaction products at more than one position along length of
11 the capillary, and a light detector positioned to collect the fluorescent light emitted the
12 excited fluorescently labeled reaction products;
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14 applying the voltage across the capillary;
15 rastering the excitation beam on the capillary;
16 monitoring the collection of fluorescent light in the light detector; and
17 comparing the position of the excitation beam on the capillary to the color of
18 light detected by the light detector to determine the position of a corresponding
19 nucleotide within the DNA sample.